XVI.—On the 25th pressure was falling on the California coast, apparently due to the advance of an area of low pressure northeastward toward Oregon; the lowest pressure was apparently nearest the coast of northern California on the 26th, p. m., after which it rapidly filled and entirely disappeared, giving place to high area No. XVI.

XVII.—On the 28th, while high areas Nos. XVI and XVII prevailed over Oregon and Saskatchewan, respectively, a trough of low pressure developed rapidly and pushed southeastward between them from Alberta to South Dakota, and on the 29th, a. m., this trough extended from Montana southeast to Kansas, while a separate branch appeared on the Gulf coast. During the 29th the central portions of the low area filled up, and the map of the 30th, a. m., shows in its place low areas Nos. XVIII and XIX central in Assiniboia and Alabama, respectively.

XVIII.—This remnant of low area No. XVII extended southeastward on the 30th and then partly filled up, so that on the 31st, p. m., it was still central in Assiniboia.

XIX.—This southern prolongation of the trough, containing low area No. XVII, was central in eastern Texas on the 29th, evidently formed under conditions favorable to a whirl initiated by the southern flow of colder air into the Gulf coast region. While moving eastward it stretched northeastward on the 30th, as a trough over the south Atlantic states, and disappeared on the 31st.

NORTH ATLANTIC STORMS FOR DECEMBER, 1893.

[*Pressure in inches and millimeters; wind-force by Beaufort scale.*]

The paths of storms that passed over the western portion of the north Atlantic Ocean are shown on Chart I, so far as can be traced from information received up to the 25th of January, through the co-operation of the Hydrographic Office, U. S. Navy, and the "New York Herald Weather Service."

The normal pressure for December, as shown by the international simultaneous observations, is highest, 30.50 (775), in central Asia between E. 80° and E. 110° on the parallel of N. 50°; it is high, 30.20 (797), in the south Atlantic states between W. 80° and W. 90° on the parallel of N. 34°. The pressure is low, 29.60 (752), in Bering Sea between longitude E. 155° and W. 155° on the parallel of N. 55°; it is lowest, 29.50 (752), in the north Atlantic Ocean in an oval stretching from southern Greenland to northern Norway. Between these centers of lowest pressure lies the Arctic region into which storm-centers rarely penetrate very far. Those that have been traced northeastward over the Atlantic during the winter months seem to turn eastward over Norway and Sweden, or if they go past North Cape they are apt to turn southeastward into Russia, and in either case they break up or die out before reaching Siberia. It seems evident that although the mechanical conditions are not unfavorable to the formation of whirls and low pressures within the Arctic circle yet the low temperature and small amount of moisture in the air constitute thermo-dynamic conditions that are unfavorable to the growth and perpetuity of such whirls. It is a matter of almost daily experience to find several independent whirls and low centers included within one large region of low pressure extending from the Aleutian Islands across North America to Greenland and extreme northern Europe, and there can be little doubt but that air flowing as upper southwest currents into such a low region from the regions of high pressure over North America and Asia and over the tropical portions of the Atlantic and the Pacific initiates these separate whirls, but it maintains them only with the help of the thermal disturbances produced by the formation of rain, snow, and clouds.

The normal pressure in December is at the maximum about 0.20 inch lower in the region between Iceland and Greenland than in November, and in general it is lower over the north Atlantic but higher over the tropical Atlantic, and over the interior of the North American continent. The region over which the maximum number of storm tracks was recorded during the years 1878–1887 passes from Japan over the southern extremity of Corea through Bering Sea to the southern extremity of Alaska; thence over the coasts of British Columbia into Oregon; thence nearly due east to southern Newfoundland; thence east-northeast over the Orkney Islands to northern Norway and Sweden; thence southeast to the interior of Russia. Observations are not at hand to trace this belt of storm-centers from Russia to the Pacific Ocean but the indications are that all cyclonic whirls are dissipated in this region of clear, dry, cold, and probably descending air.

The average velocity of movement of the north Atlantic storms in December is about 21 statute miles per hour over the north Atlantic Ocean, but about 36 miles per hour over the United States, where the movement is more rapid than in any other part of their course from Bering Sea to Europe. During the 10 years, 1878 to 1887, 3 storms were traced continuously over the entire North American continent and the Atlantic Ocean and 1 storm over that continent and ocean and Europe.

During December, 1893, the following areas of low pressure, with revolving winds, have been approximately traced on the Atlantic Ocean:

A. This was the continuation of low area No. II over the United States, as above described; it passed northeastward over southern Newfoundland, and on the 4th apparently approached Iceland.

B. This was central on the 4th, a. m., in the Gulf of Saint Lawrence and was a continuation of low area No. I of the United States series; it passed rapidly northeastward, being south of Iceland on the 6th, after which it turned northward.

C. This was low area No. IV of the United States series; it was central near Cape Breton on the morning of the 6th, and was south of Iceland, approximately at N. 58°, W. 12°, on the 8th, while severe gales raged in the northern part of Great Britain, Ireland, and over the ocean to the westward and southward; it then turned northeast.

D. This seemed to have started as an extreme western branch of *C* in the region of northwesterly gales that prevailed on the 8th south of Greenland; it was central on the 9th in about N. 58°, W. 28°, and on the 10th, in about N. 55°, W. 12°, as a long oval or trough; it disappeared on the 11th north of Great Britain in the course of the development of a very large area of very low pressure whose center was farther north.

E. This small whirl was located on the 11th as an extension of *D* to the south-southwest; by the 12th it had moved slightly northward.

F. This whirl was also located on the 11th, when it was west of *E* in N. 50°, W. 35°; it moved eastward slowly, and on the 12th both *E* and *F* were comprised within a trough extending from W. 15° to W. 45° and about N. 52°. Farther west or northwest this trough joined low area No. VII of the United States series, which had extended rapidly northeastward.

G. This was a continuation of low area No. VII of the United States series, which, after moving to the southeast of Newfoundland, turned eastward and joined *F* and *E* on the 15th, forming a region of low pressure which at that time

apparently extended from N. 60°, W. 20°, to N. 65°, E. 10°; by the 18th the eastern portion of this low pressure had passed North Cape and turned southeast into Russia.

H. This was the continuation of low area No. IX of the United States series, which was central in the Gulf of Saint Lawrence on the 17th; it passed toward east-northeast rapidly and was off the coast of Ireland on the 19th; then moved northeast, while a secondary depression formed in the Irish Channel; it was almost stationary between Scotland and Iceland from the 20th to the 22d, when it was joined by *I*, and, together with *J* and *K*, developed into a large area of low pressure which, on the 25th, extended from the middle of the north Atlantic over Scandinavia and Russia.

I. This was a continuation of low area No. XI of the United States series, which, on the 20th, was central south of Newfoundland and moved thence northeast, being at N. 57°, W. 35°, on the 21st, and N. 60°, W. 15°, on the 22d, when it had joined with *H*.

J. This was the continuation of low area No. XII, United States series, which passed eastward over southern Labrador on the 21st, and was central on the 23d at about N. 56°, W. 30°. On the 24th it was apparently south of Iceland, and on the 25th at N. 64°, W. 5°.

K. This was a continuation of low area No. XIII, which was central south of Newfoundland on the 24th, and at N. 52°, W. 35°, on the 25th; it passed quite near Iceland, while an area of high pressure pushed northward over Europe, so that, on the 28th, a region of low pressure apparently connected *K*, *L*, and *M*, and extended from James Bay and Lake Superior over Labrador and southern Greenland. On the 29th and 30th the extreme northeastern end of this region moved southeast and developed into an extensive low area in northern Russia on the 30th and 31st, which apparently represents the further development of the North Atlantic storm area *K*.

L. This was a continuation of low area No. XIV of the United States series, which was central east of Cape Breton on the 26th. It developed into a long oval on the 27th, and disappeared on the 29th southwest of Iceland as a branch of the extensive low pressure just described.

M. This was a continuation of low area No. XV, United States series, which was central on the southern coast of Labrador on the 29th; it moved east-southeast and was at N. 47°, W. 47°, on the 30th, after which it filled up and disappeared in the presence of the extensive area of high pressure that then stretched from central Europe westward to the middle of the Atlantic.

OCEAN ICE IN DECEMBER.

The limits of the regions within which field ice or icebergs were reported for December, 1893, are shown on Chart I by crosses. On the 27th one small berg was reported in N. 47° 05′, W. 50° 43′; on the 29th one large berg was observed in N. 47° 16′, W. 49° 36′; on the 31st in N. 47° 35′, W. 49° 00′ a berg about 60 feet high was reported.

In December, 1882, 1883, 1884, 1886, and 1888, no Arctic ice was reported near Newfoundland and the Grand Banks. In 1885 several bergs were observed off the Newfoundland coast the early part of the month. In 1887 a small berg was reported in N. 46° 10′, W. 47° 28′ on the 26th, and a small berg in N. 48° 20′, W. 48° 40′ on the 28th. In 1889 large quantities of Arctic ice were reported over and near the Grand Banks. In 1890 a large berg was observed in N. 49° 39′, W. 47° 50′ on the 13th. Arctic ice was not reported for December, 1891 and 1892.

OCEAN FOG IN DECEMBER.

The limits of fog belts west of the 40th meridian, as determined by reports of shipmasters, are shown on Chart I by dotted shading. East of the 55th meridian fog was reported on 11 dates; between the 55th and 65th meridians on one date; west of the 65th meridian fog was not reported on any date. Compared with the corresponding month of the last 6 years the dates of occurrence of fog east of the 55th meridian numbered 7 more than the average, and west of the 55th meridian 4 less than the average.

TEMPERATURE OF THE AIR (expressed in degrees Fahrenheit).

The distribution of the monthly mean temperature of the air over the United States and Canada is shown by the dotted isotherms on Chart II; the lines are, however, not drawn for the higher irregular surface of the Rocky Mountain plateau; the temperatures have not been reduced to sea level, and the isotherms, therefore, relate to the average surface of the country over which they are drawn; in mountainous regions such isotherms would be controlled largely by the topography, and it is, therefore, not practicable to present the temperature data in this manner unless a contour map on a large scale is published as a base chart.

In the table of meteorological data from voluntary observers the actual mean temperature is given for each station, and in the tables of climatological data for the regular stations of the Weather Bureau both the mean temperatures and the departures from the normal are given. In the latter table the stations are grouped by geographical districts, for each of which is given the average temperature and departure from the normal. The normal for any district or station may be found by adding the departures to the current average when the latter is below the normal and by subtracting when it is above.

For the regular stations of the Weather Bureau the monthly mean temperature is the simple mean of all the daily maxima and minima; for voluntary stations a variety of methods of computation is necessarily allowed, as shown by the notes appended to the table of meteorological data.

During December, 1893, the mean temperature was highest (70.8) at Key West. The temperature averaged between 60 and 70 throughout the peninsula of Florida and on the immediate coast of Louisiana and Texas; it was slightly above 60 at a few stations in southern California near Arizona. The temperature averaged 32 in a zone that included Cape Cod, Rhode Island, southern Connecticut, northern New Jersey, central Pennsylvania, Ohio, Indiana, Illinois, northern Missouri, northern Kansas, southern Nebraska, the greater part of Colorado, Utah, northern Nevada, eastern Oregon, and northeastern Washington. The lowest average temperatures appearing on our maps were —8.0 at Winnipeg, Manitoba, and —8.2 at Prince Albert, Saskatchewan.

DEPARTURES FROM NORMAL TEMPERATURE.

As compared with the normal for this month temperatures have been deficient by about 5, or more, in northern New England, the Valley of the Saint Lawrence, the northern portion of the Lake region, Wisconsin, Minnesota, and Manitoba. Among the principal deficits are: —5.1 at Chatham, N. B., —8.7 at Rockliffe, Ont., —13.8 at White River, Ont., —11.0 at Winnipeg, Manitoba, and —9.0 at Moorhead, Minn. The temperature has been normal or above normal in all the south Atlantic and Gulf states and the Pacific coast and Rocky Mountain region. The maximum excesses have been: +5.5 at Dodge City, Kans., +4.9 at Corpus Christi, Tex., +4.3 at Abilene, Tex., +4.2 at Denver, Colo.

The following table shows for certain stations, as reported